NATO Advanced Research Workshop METALLIC MATERIALS WITH HIGH STRUCTURAL EFFICIENCY, Kyiv, Ukraine, September 7-13, 2003

Nanostructured and Nanocomposite Light-Metal Based Compounds for Hydrogen Storage

R.A. Varin[1)], Ch. Chiu[1)], S. Li[1)], L. Guo[1)], A. Calka[2)]

[1)]*Department of Mechanical Engineering, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1*
[2)]*Faculty of Engineering, University of Wollongong, Wollongong, NSW 2522, Australia*

Hydrogen is emerging rapidly as a major component of clean, sustainable energy systems. However, onboard hydrogen storage for proton exchange membrane (PEM) fuel cells for vehicular applications remains an undisputed problem. The most common storage systems such as high pressure gas cylinders and cryogenic tanks for liquid hydrogen suffer from inherent safety problems and relatively low *volumetric* densities (~40 kg m^{-3} for gas under 80 MPa and ~71 kg m^{-3} for liquid hydrogen). The highest volumetric densities of hydrogen are found in solid metal hydrides (150 kg m^{-3}) and simultaneously, high *gravimetric* densities can be achieved by utilizing light-metal compounds based on Li, Mg, B and Al. The most interesting for further development as hydrogen storage materials are complex hydrides such as Mg_2NiH_4 (3.6wt%H), Mg_2CoH_5 (4.5wt%H), Mg_2FeH_6 (5.4 wt%H), Mg_3MnH_7 (5.2wt%H), $NaBH_4$ (10.6wt%), $Mg(BH_4)_2$ (15.3wt%H) and $LiBH_4$ (18.4wt%H). Further enhancement of their hydrogen sorption/desorption properties could be achieved by creating ***nanostructured/nanocomposite*** materials using mechanical alloying (MA) and/or milling (MM). The present paper is an overview of our recent results on the nanostructural processing and synthesis of complex hydrides in the Mg-M-H (M=Fe,Ni,Co,Mn,B) and (Li/Na)BH_4 systems by using Controlled Reactive Mechanical Alloying (CRMA) and Milling (CMM) in the magneto-mill Uni-Ball-Mill 5. Under ***shearing*** mode of milling the principal nanocrystalline hydride being created in the Mg-M-H (M=Fe,Ni,Co,Mn,B) systems is MgH_2 whose nanograin size can be immensely reduced to the range of 20-10 nm. In the Mg-B-H system X-ray diffraction indicates the presence of a small amount of nanostructured $Mg(BH_4)_2$. The Mg-Fe-H systems shows *amorphization* of hydrides and elemental Mg. Nanograin size of $NaBH_4$ hydride remains within 100 nm range even after 100h of CMM which indicates its high structural stability.